



# REASONING PATTERN AND PERSONAL QUALITIES OF SUCCESSFUL MATHEMATICS TEACHERS

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## ABSTRACT

It is an alarming situation that students are not doing well in mathematics at school as well as at college and university level in India. There is a need to pay attention to this problem. A very small portion of the students passing out of school system prefer to study mathematics as a main subject at college/university level. Those who pass their secondary level examination prefer to go either to the engineering courses or to medical courses. If they are unable to find seats in either of these professional courses, they take up admission in any undergraduate programme just to get themselves enrolled in the university and prepare for another chance for admission to professional courses mentioned above, and do not pay serious attention to the courses at undergraduate level, which they pursue. Many of those who go for study of mathematics as a subsidiary subject with less interest do not take the subject seriously and feel contented with minimum test scores required for a pass. Out of 1100 secondary school pass-outs included in the sample for this study, only 2.09% studied mathematics at postgraduate stage and preferred to join the Bachelor of Education (B. Ed.) course and undergo training as teachers of mathematics. The major objective of this paper is to answer the question why we are not getting good mathematics teachers for schools in India.

## Introduction

Teacher is a social architect as well as the maker of mankind, the quality and the performance of education system depends on him/her. The qualification and training of teachers, therefore, acquire prominent position in the educational establishment. Teachers should be properly trained in order to ensure better outcomes in this field and to accelerate the progress of the society. Dedicated and well-equipped teachers can achieve the prosperity of a society. The education transformation in a society is an on-going process, and therefore, the teachers training should be in tune with the needs of the former. Knowledge of the subject, teaching skills, interest in the job and positive attitude towards teaching profession are some of the essential qualities, which a teacher must possess.

In India, mathematics and science are compulsory subject of study for children at school stage. The progress of a society in modern times is dependent on the quantity and quality of scientists and technologists produced by its education system. The curriculum of the teacher education program, especially in mathematics, should be in line with the changing realities of the society. It has been observed that some students at school stage have developed some kind of 'fear' of mathematics and also a tendency to avoid mathematics class. The teacher education programs should equip teachers of mathematics with skills to remove this fear of mathematics in the teenagers. In India, different committees have discussed the programs of teacher education in detail and commissions set up by the government which have recommended appropriate actions to be taken for removing the weaknesses in this regard. In spite of all the steps taken by the government and by the responsible bodies, the teacher education program in mathematics has not been up to mark, perhaps because of the non-serious efforts and casual attitude of the institutions of teacher education. Thinking about this problem, Ogochukwu (2010) suggested that the need of the hour was that mathematics teachers should give serious thought to determine how they could possibly capture the attention of teen-agers distracted by various problems and events in their daily lives. Although, teacher trainees have made some efforts towards improving these trends, students' lack of interest in continuing the study of mathematics beyond secondary school level was still a tremendous problem. The success of provisions of guided experiences in schools or school-like situations depends upon approaches for improvement of program skills and competencies during pre-service training of teachers. Stones and Morris (1972) expressed, "Practice teaching should aim to .....develop in students, but also in their appraisal of the institution in which they teach". National Classification of Occupations (NCO) classified, defined and briefly described various occupations of civilian labour force of India and due to this classification 'occupation' is trade, profession or type of work performed by an individual, independent of the worker's industry, status or years of experience". In India, teaching is considered as the noble profession, but there are many working teachers (at kindergarten, nursery, primary and middle teaching) who do not accept it as a profession, or we may say that they are not performing on it as a profession because they do not possess some qualities which are the characteristics of occupation of teaching to be called as profession.

In view of the above criterion, we may say that occupation of teaching cannot achieve the status of a profession. In the present scenario, teaching community is a composition of persons with varying degree of educational preparation while in the past many less motivated people entered teaching jobs with very little preparation. No occupation can be rated as high as teaching because of its social values and its contribution to the betterment of individual, which ultimately leads to the

betterment of the society. Unfortunately, in India, teaching is not a preferred job for the youth due to various socioeconomic reasons. After completion of school education, most young men seek to join professional courses like engineering, law and medicine. In case they are not selected for any professional course even after repeated attempts they take up the undergraduate courses in arts, science or commerce half heartily. That means, at undergraduate level in general education, we are getting the residue after the professional streams have taken the creamy layer of students of the secondary level away. Out of this group of residual class, some try to do well at the undergraduate level and take up study of mathematics as well as some subsidiary subjects just to get good marks by cramming the theorems and the results without any understanding. After passing their undergraduate course, they look after other options such as management courses, computer application courses and other alternatives. If they are not selected in either of the professional courses then they are forced to go for masters in mathematics just to get a master's degree.

In the present study the investigator attempted to answer the question "what proportion of secondary school pass-outs prefer to join higher studies in mathematics and decide to become teachers of mathematics?" For this purpose, a sample of 1100 students of secondary schools (both the sexes) affiliated to Aligarh Muslim University (India) was selected and a longitudinal study was conducted. To a great surprise of the investigator, it was found that at master's level in mathematics only 23 students out of 1100 included in the sample appeared in the entrance test, that is, only 2.09% students appeared in the admission test for master's program in mathematics. When they were given a questionnaire to find out as to how many had appeared in the admission tests for any of the professional courses, then it was found that 20 of these 23 students had appeared in the competition tests at some stage. It was also indicated that study of mathematics at higher education stage and getting trained as mathematics teacher for school stage was their last choice. In this paper, we suggest that the attention should be paid to get good teachers at the primary as well as secondary levels of schooling and train them to develop desirable characteristics of a good teacher.

The quality of the teachers produced by teacher training institutions depends largely upon the quality of persons who are given admission to teacher education courses. The poor quality of students being admitted to teachers training institutions was one of the reasons for such criticism. Tobin and Gamett (1984) revealed that students with high formal reasoning ability were best equipped to teach primary school science. Pandey and Gayatri (1990) reported that nearly 58% of the prospective secondary school science teachers functioned at formal operational level. The reviews of related studies [Rajput and Walia (1994), Griffith et al (1999) and Khan (2000; 2001)] on personal characteristics of teachers revealed that various methods had been followed for identifying qualities of effective teachers. These studies, therefore, suggested that attention should be paid to get good teachers at the primary level as well as at the secondary level. Therefore it was felt that formal reasoning ability is an important trait for a successful teacher of mathematics. Hence, a need was felt to investigate the reasoning pattern and personal characteristics as determinants of success of teacher trainees and development of characteristics of a good teacher.

## Objective

The present study seeks to:

- Study the choice of Indian youth to study higher mathematics and join teaching job at school stage as mathematics teacher.

- Investigate the degree of reasoning ability of teacher trainees with specific purpose to see whether reasoning patterns used by them were appropriate.
- Analyze the personal characteristics of teacher trainees as successful/unsuccessful mathematics teachers on a fairly objective basis.

### Material and method

The investigator used three research instruments: (1) Tarkik Chintan Parikshan (TCP) developed by Bhattacharya and Pandey (1990) for studying reasoning pattern of teacher trainees, (2) Test of Logical Thinking by Tobin and Capie (Hindi adaptation), and (3) Flanagan's Critical Incident Technique (1954) for assessing personal characteristics. The TCP is a 10 item multiple choice test containing five reasoning modes as given below:

- Proportional reasoning, 2. Controlling variables, 3. Probabilistic reasoning, 4. Co-relational reasoning, 5. Combinational reasoning

### Each mode has two test items.

Flanagan's Critical Incident Technique (1954) was used to determine personal characteristics of successful teacher trainees. Based on this technique, a questionnaire was developed and used for collecting data. It included the following questions. The responses were elicited from the students because student's evaluation of their teachers is considered trustworthy (Prosser and Trigwell (1997)).

**Question1.** *Think of the most effective student teacher with whom you have been closely associated. The person you have in mind probably did many things that convinced you that he or she was effective, but what was that outstanding act which made you consider him/her especially effective? Describe that effective act that he/she did which made him/her stand out in your mind as being particularly effective in the job.*

**Question2.** *Think of the student teachers with whom you have been closely associated. Of those teachers, think of the one whom you consider most ineffective. The teacher you are thinking of probably did a lot of things, which caused you feel that he/she was ineffective, but what was the particular incident that stands out in your mind as a clear-cut example of ineffectiveness? Describe the situation and just what the teacher did that convinced you of his/her ineffectiveness in the job.*

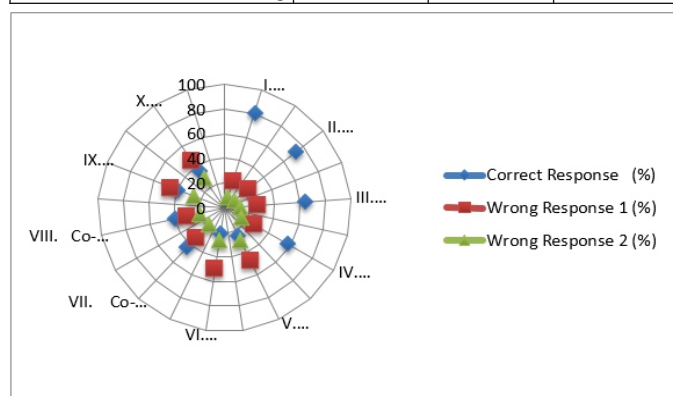
The pupils reported altogether over 150 behaviours, which included characteristics of successful and unsuccessful teachers. These incidents were scrutinized to discover major characteristics. The characteristics were classified and categorized to yield major categories. About eleven categories of successful and unsuccessful student teachers in mathematics were finally listed.

### Results

Results of each reasoning mode as assessed by the TCP has been presented in the following table in terms of the percentage of respondents giving correct/incorrect responses.

**TABLE**  
**Response Pattern on TCP Items**

Reasoning Mode	Correct Response (%)	Wrong Response 1 (%)	Wrong Response 2 (%)
I. Proportional Reasoning	80.4	22.5	9.3
II. Proportional Reasoning	72.6	24.2	10.4
III. Controlling Reasoning	64.2	25.8	12.1
IV. Controlling Reasoning	58.0	26.7	14.8
V. Probabilistic Reasoning	25.4	46.8	28.6
VI. Probabilistic Reasoning	20.9	49.5	26.2
VII. Co-relational Reasoning	43.4	33.2	18.3
VIII. Co-relational Reasoning	39.8	30.7	20.5
IX. Combinational Reasoning	39.8	45.9	26.7
X. Combinational Reasoning	35.3	45.8	29.4



The table summarizes that out of the total number of participants in this study, only 80.4% and 72.6% responded correctly with justification while 22.5% and 24.2% of the participants responded with an additive answer. Furthermore, 9.3% and 10.4% of the respondent answered with the reasoning mode for items I and II respectively. The result of this study have proven that the participants who answered correctly used proportional reasoning rather than additive, similar to the findings of Inhelder and Piaget (1958) and Karplus et al (1977).

The assessment of controlling reasoning of the TCP – test are the items III and IV that was answered by 64.2% and 58.2% respondents respectively. Furthermore, the most common incorrect response, compared by the whole pendulum was chosen by 25.8% and 26.7% and these responses are not random. The next most common wrong response attempted by students was that the extreme cases be compared which was chosen by 10.4 % & 12.1% students on items respectively. The findings related to incorrect reasoning patterns of the present investigation also find support by the studies of Wollman (1977) and Capie et al (1981).

The responses of teacher trainees in Mathematics were analysed to find out that 25.4% and 20.9% gave correct response and justification to items V and VI respectively. The present study wherein 46.8 % and 49.5% gave wrong answer and justification supported the result of Tobin and Garnett (1984) where most common wrong response pattern on items of probabilistic reasoning was focused on the total number of objects in the set. The second common wrong response pattern focusing on the number of objects in the favored subset was given by 28.6% and 26.2% students on the above items.

The items VII and VIII of the test are concerned with co-relational reasoning and were correctly answered by the 43.4% and 39.8% students respectively. Analysis of responses reveals that common wrong responses were either based on consideration of one variable only (33.2 % and 30.7%) or justified in terms of an imperfect relationship that is 18.3% and 20.5%.

The assessment of combinational reasoning is the last two items of the test concerned. 39.8% and 35.3% of the student generated all combinations correctly while 45.9% and 45.8% respondent used incorrect pattern for both the items. 26.7% of the students on item number IX and 29.4% of students on item number X generated combination, which suggested that they had tried to control variable but failed to generate all possible combinations.

The present study yielded the following characteristics and each of these characteristics could be objectively described on the basis of incident related to them.

- Appearance (physical), 2. Appropriate voice, 3. Scholarship/knowledge, 4. Blackboard work, 5. Organized teaching, 6. Sympathetic Attitude, 7. Energetic, 8.Originality, 9. Questioning skill, 10. Confidence, 11. Class management

After identifying the above characteristics, attempts were made to group them into homogenous categories. The following categories of teacher characteristics resulted: -

Categories	Characteristics
Personal qualities	1, 2, 6, 7, 10
Professional competence	3, 8
Class-room performance	4, 5, 9, 11

The identification of teacher characteristics and their above mentioned categorization resulted in a set of qualities of effective teachers which are likely to be very objective.

### Discussion

- The present study reveals that the majority of teacher trainees in Mathematics are not fully formal operational, and furthermore, incorrect reasoning patterns used by them are not random as most of the wrong responses form a set pattern.
- An analysis of the school curricula would reveal that different reasoning modes are pre requisite for teacher trainees in Mathematics to understand the concept. Attainment of proportional reasoning is necessary for understanding and derivation of functional relationships, interpretation of tabulated data and graphs etc.
- The concepts of probability and co-relations are important aspects for teacher trainees in Mathematics. Combinational reasoning involves use of all possible combinations or factors related to a problem. This reasoning mode is usually required at the planning phase of the activity. National Policy of Education (NPE) advocated a child centered and activity based process of learning. Activity based course required students to identify, control and manipulate variable.
- The identification of personal characteristics in a set of qualities of successful teacher trainees, which are likely to be very objective because they have been abstracted from actual classroom situations.

- The teacher rating scale developed in this study has sufficient content validity because the characteristics of successful teacher trainees in Mathematics have been abstracted from objective situations.
- The statistical validity was also computed by co-relating the rating on this scale teacher trainees practice teaching marks.

### Conclusions

1. It was revealed that post-secondary students preferred to go to either in the Engineering courses or to the Medical courses as their first choice. If they are not selected either of these courses then they take admission in the undergraduate program just to get themselves enrolled in the university and try for another chance for admission to the professional courses mentioned above and did pay attention to the courses at undergraduate level. This indicates that the sample which we get for the undergraduate level only take mathematics or the other subsidiary courses casually and study them only to pass without any understanding of the subject. In case they are not selected again in any professional course for their second attempt either they try for the last chance for the same or they take up the undergraduate course half heartily. That means that we are getting the residue of the creamy students of the secondary level students at the Undergraduate level. Out of this sample of residue class some of them try to do well at the undergraduate level and do mathematics as well as the subsidiary subjects just to get good marks by only cramming the theorems and the results without any understanding. After passing their Undergraduate course, they look after other options, i.e. management courses, computer application courses and other alternatives as their second choice. If they are not selected in either of the courses then they are forced to do Masters in mathematics as their last choice just to get a Master's degree and become teacher trainees in mathematics.
2. The importance of identifying various reasoning abilities and personal characteristics of teacher trainees in Mathematics as determinants of success in teaching is the main finding of the study. Teachers should also help students to facilitate acquisition of various reasoning pattern in addition to his normal duties to teach the subjects. This object can be achieved when teacher become aware of the limitation of student's reasoning pattern and thus will be capable of formal reasoning. The study show the importance of reasoning ability clubbed with qualities like – personal qualities, professional qualities and class-room performance, for promoting abstract learning with cognitively immature student and preparing them for teaching abstractions and reasoning skills.

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